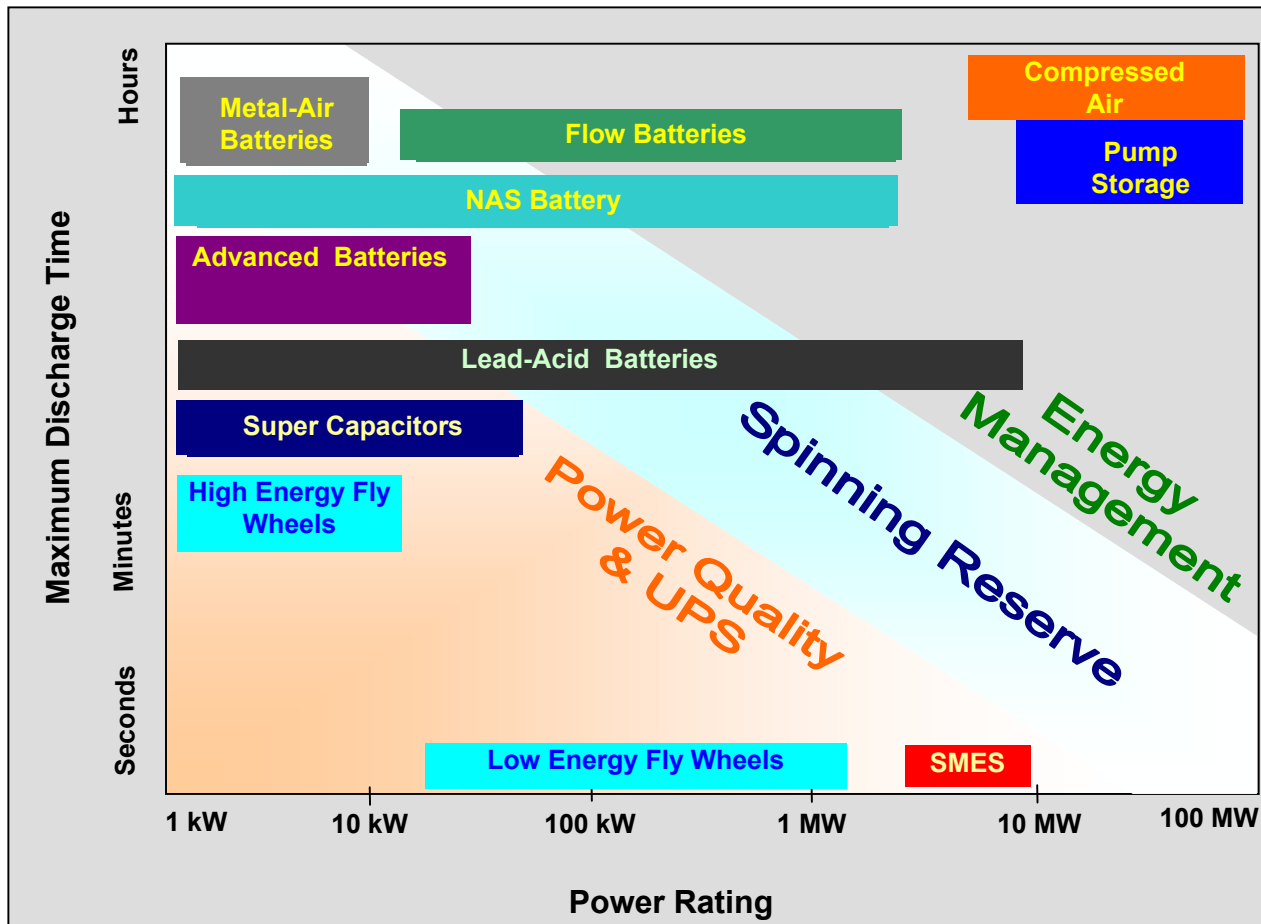


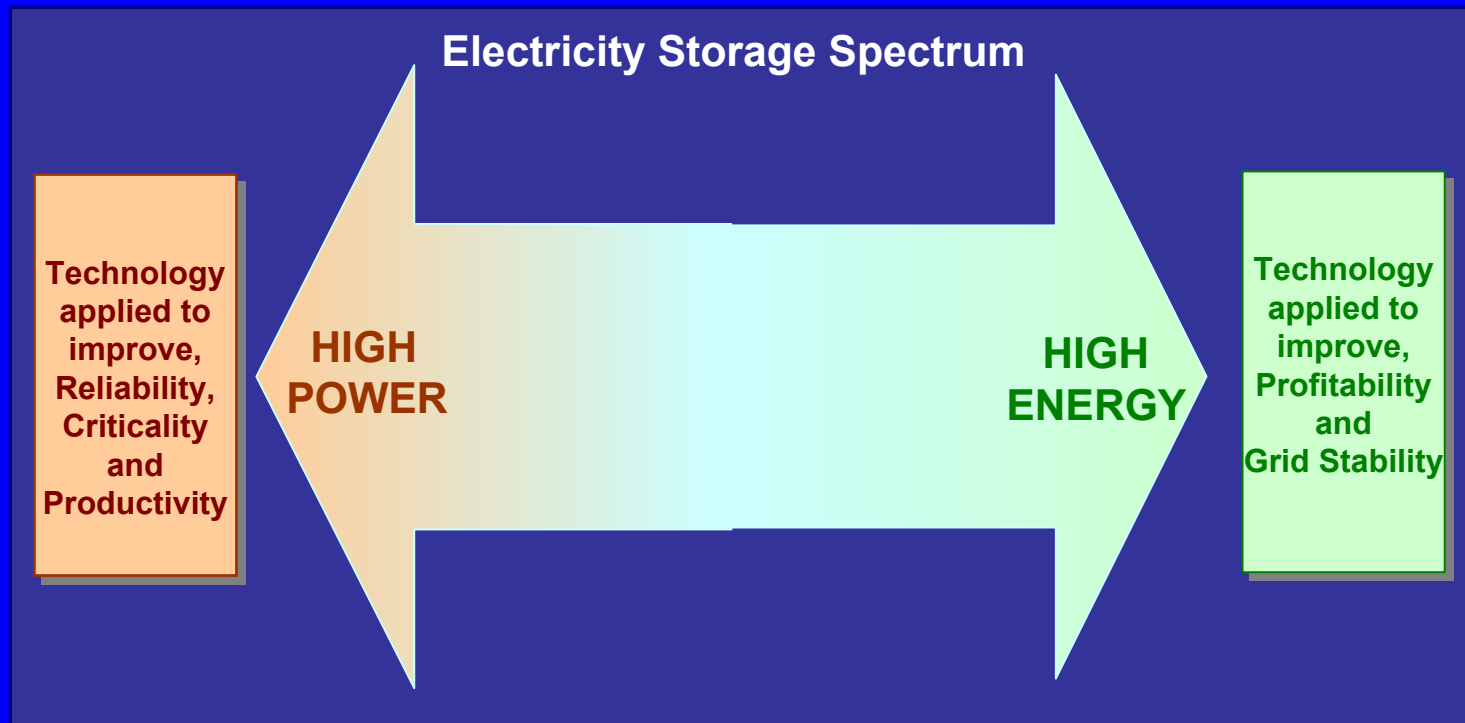
# **ENERGY STORAGE**

## **TECHNOLOGIES AND APPLICATIONS**

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IMRE GYUK, PROGRAM MANAGER  
ENERGY STORAGE RESEARCH, DOE





The Digital  
Economy

Restructured  
Energy Market

**RELIABILITY**

**FOR A**

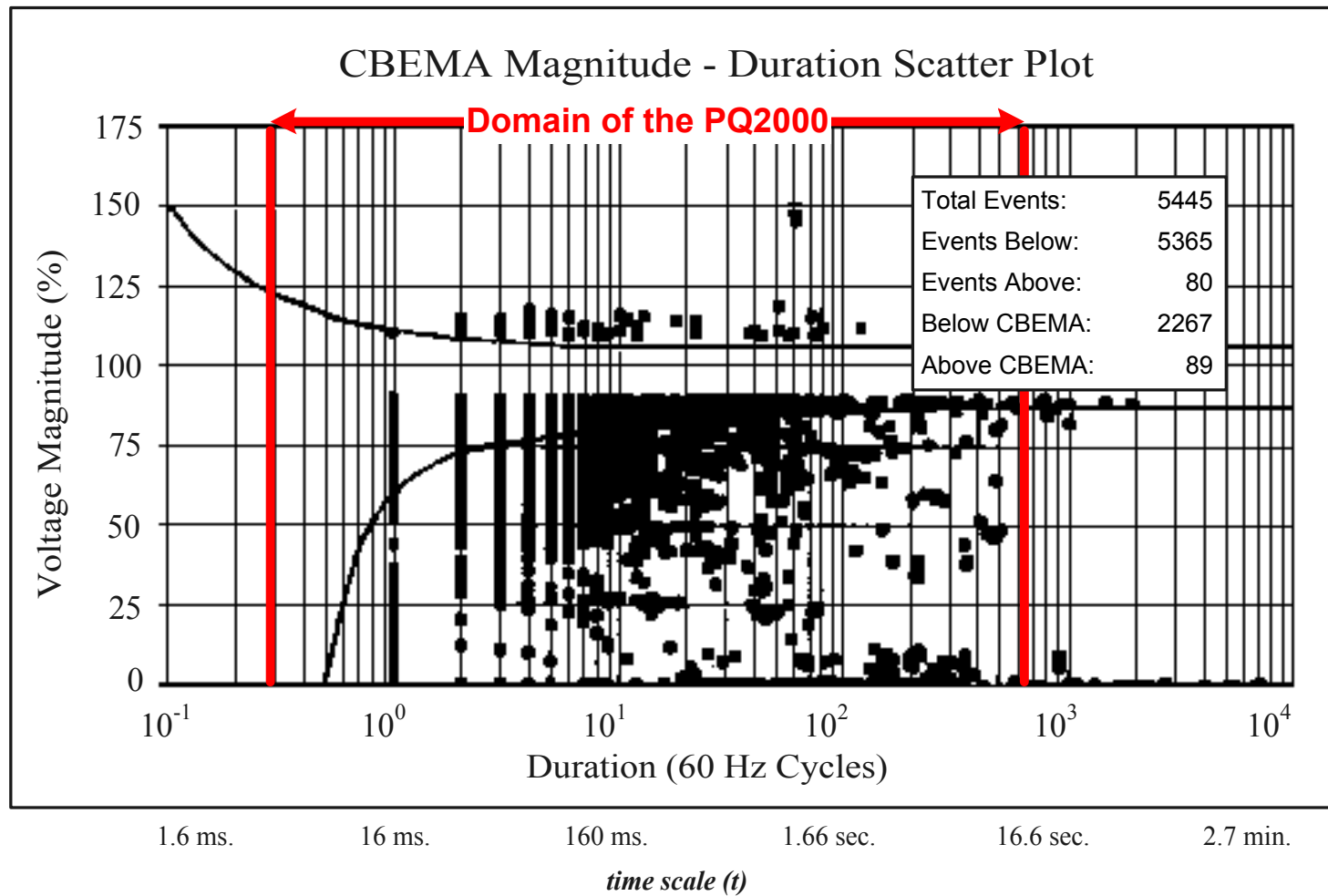
**DIGITAL WORLD**

**TELECOMMUNICATION**  
**FINANCIAL TRANSACTIONS**  
**MASS TRANSPORTATION**  
**e-COMMERCE**  
**HIGH TECH MANUFACTURING**  
**etc. etc.**

- **POWER QUALITY EVENTS:  
MICRO-OUTAGES, VOLTAGE  
SAGS, SURGES - ARE FATAL!**
- **PQ EVENTS ARE EXPENSIVE:  
ESTIMATED YEARLY LOSSES  
ARE 30 – 150 BILLION  
DOLLARS!**

# REQUIRED RELIABILITY FOR DIGITAL TECHNOLOGIES:

- 1 CYCLE / YEAR =  
99.999 999 947% = NINE NINES
- AVAILABLE FROM THE GRID:  
99.9% = 3 NINES



**MOST OUTAGES:**

**FEW CYCLES  
TO SEVERAL SECONDS**

**DESIGN PERIOD:  
15 - 30 SECONDS**

**SEAMLESS POWER CAN ONLY BE  
PROVIDED BY ENERGY STORAGE!**

**BUT FOR LONGER OUTAGES,  
DG PROVIDES NEEDED BACKUP**

**ENERGY STORAGE  
AND DISTRIBUTED  
GENERATION  
ARE COMPLEMENTARY**

**RELIABILITY REQUIRES  
STORAGE SYSTEMS  
WITH HIGH POWER OUTPUT  
FOR SHORT PERIODS**



**10 MW - 15 sec System at Microchip Plant**

# **10 MW LEAD ACID BATTERY SYSTEM**

**PROVIDES SEAMLESS  
POWER**

**FOR A MICROCHIP PLANT**

**AFTER 15 SECONDS**

**A QUICK-START**

**GENSET TAKES OVER:**

**1 – 2 YEAR PAYBACK!!**

**LOAD MANAGEMENT  
FOR A RESTRUCTURED  
ENERGY MARKET**

# **ELECTRICITY RESTRUCTURING**

**WAS INTENDED TO  
  
MAKE THE MARKET  
ECONOMICALLY  
SELF-CORRECTING**

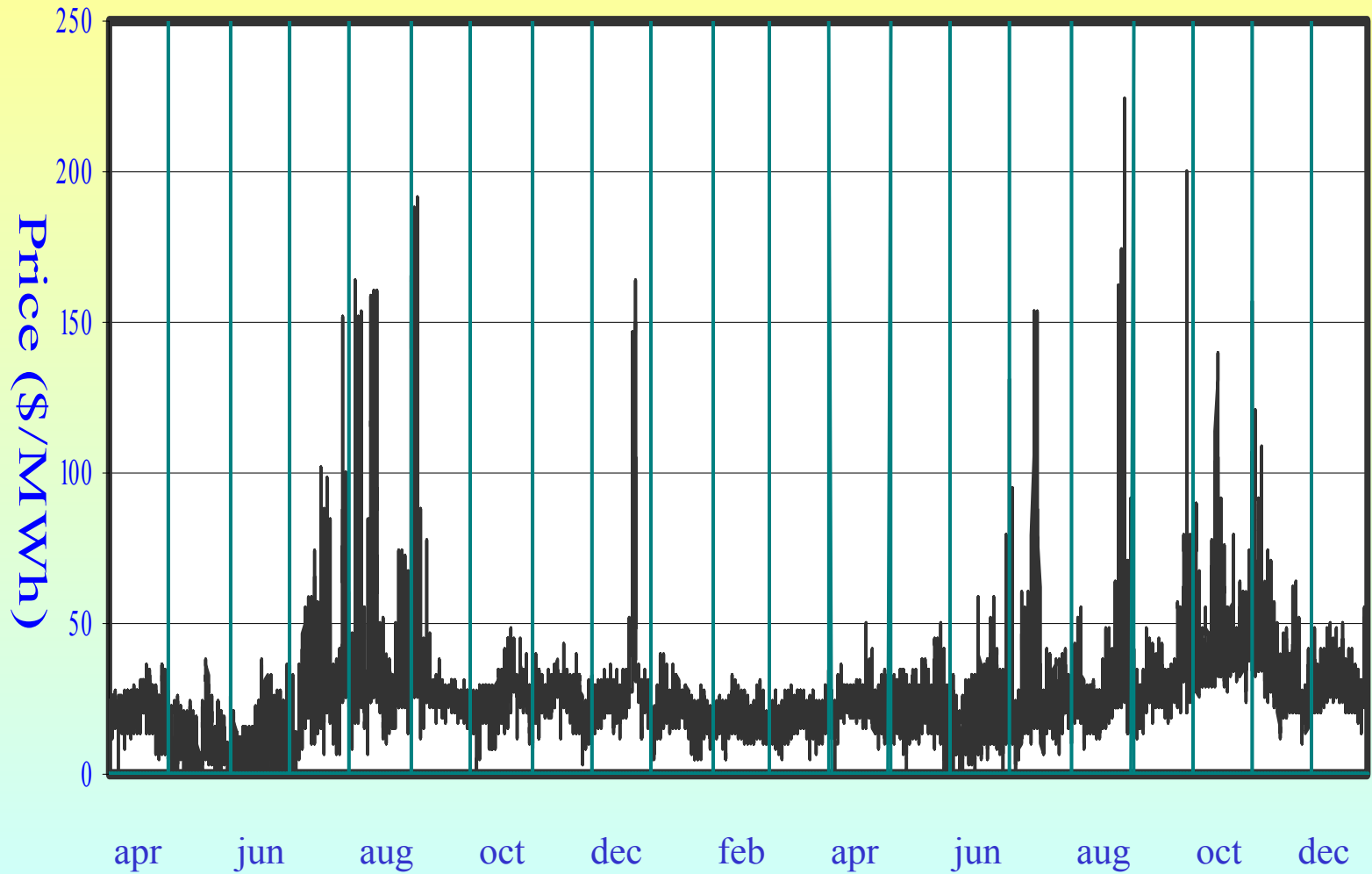
**BUT ACTUALLY**

**THE MARKET**

**IS VERY INELASTIC:**

**NO REAL RESPONSE!**

# California Spotmarket 1998-1999



**NEW ENGLAND:**

**PEAK LOADS VARY 50%**

**PRICE SPIKES ARE 10 000%**

**!!!!!!**

**50 HOURS OF OPERATION**

**ACCOUNT FOR**

**1/6 THE WHOLESALE COST**

**!!!!!!**

**SUCH RESPONSE  
IS TYPICAL  
FOR A SEVERELY  
STRESSED SYSTEM**

**LOAD LEVELING WITH  
ENERGY STORAGE OR  
DISTRIBUTED GENERATION  
IS A VITAL PART OF THE  
SOLUTION**

**THIS REQUIRES  
STORAGE SYSTEMS  
WITH SUBSTANTIAL  
ENERGY CONTENT**

**6 MW / 8hr (NaS)**

**PROVIDES**

**LOAD LEVELING**

**FOR OHITO, JAPAN**



**6 MW / 8hrs Sodium-Sulfur Battery**

**NEW ENGLAND:**

**2000 MW DC LINE FROM  
QUEBEC**

**800 MW UNUSED DUE TO  
POTENTIAL VOLTAGE  
COLLAPSE**

**STORAGE CAN MAKE  
RENEWABLES  
LIKE WIND AND SOLAR  
DISPATCHABLE**

**STORAGE WILL ALLOW  
WIND FARMS TO BID  
ON THE SPOT MARKET**

**BIDS TYPICALLY REQUIRE**

**24 HOUR ADVANCE**

**WITH 250% PENALTY**

**FOR NON-DELIVERY**

# **VIRGINIA COMMUNITY CENTER**

- **75 KW PHOTO-VOLTAIC**
- **TWO 100 KW / 1 KWh ZnBr BATTERIES**
- **GRID CONNECTED FOR BACKUP**
- **GREEN POWER SELL-BACK PLANNED**



**1 kW / 1 kWh ZnBr Battery System**

# **ENERGY STORAGE CAN:**

- **PROVIDE HIGH NINES RELIABILITY**
- **PEAK SHAVE PRICE SPIKES**
- **MAKE RENEWABLES DISPATCHABLE**
- **ENABLE DG TO LOAD-FOLLOW**